USE OF CHLORINE DIOXIDE AND CHLORITE FOR CONTROL OF NITRIFICATION IN MAERKLE RESERVOIR: A FULL-SCALE DEMONSTRATION

STANDARD OPERATING PROCEDURE
(SOP)

May 10, 2002

CARLSBAD MUNICIPAL WATER DISTRICT

McGuire Environmental Consultants, Inc.

Table of Contents

I. INTRODUCTION

The Carlsbad Municipal Water District's (CMWD) 200 million-gallon Maerkle Reservoir receives chloraminated water from the Metropolitan Water District of Southern California's Skinner Filtration Plant through the Tri-Agency Pipeline. Maerkle Reservoir (like many other finished water reservoirs in Southern California) is susceptible to nitrification due to extremely long detention times. To control nitrification, the reservoir influent is breakpoint chlorinated to remove ammonia, which eliminates the food source for nitrifying bacteria. However, this breakpoint chlorination practice, coupled with long detention times, results in the formation of higher levels of DBPs. Currently, CMWD is well below the Stage 1 Disinfection Byproducts standard but there is concern that the more stringent Stage 2 MCLs and method of calculation may cause non-compliance in the future. Thus, CMWD is investigating methods to eliminate the practice of breakpoint chlorination while simultaneously preventing nitrification from occurring in Maerkle Reservoir.

A recently published study by McGuire et al. in the *Journal of American Water Works Association (***91***:10:52)* concluded that the use of chlorine dioxide during the water treatment process provided increased distribution system protection against chloramine residual loss and nitrification. This effect was attributed to chlorite inhibiting the activity of nitrifying bacteria, which in turn inhibits nitrite production and nitrite's role as an oxidant demand. The benefits were substantial, as reflected by 100% improvements in preserving ammonia and total chlorine residuals with distance from the treatment plant. Bench-scale tests were conducted to corroborate these findings, and identified the range of chlorite residuals that are necessary to inhibit nitrifying bacteria. The effective chlorite concentrations were found to range from 0.05 to 0.5 mg/L, which is significantly less than the chlorite MCL. CMWD intends to test this application as a means of controlling nitrification in Maerkle Reservoir and avoid breakpoint chlorination.

This is the Standard Operating Procedure (SOP) for chlorine dioxide application and residual chlorite inhibition of nitrification for this investigation.

II. CHLORINE DIOXIDE

For this investigation, chlorine dioxide will be generated from reacting sodium chlorite solutions with gaseous chlorine ($Cl_{2(g)}$). The reaction is:

$$2\ NaClO_2 + Cl_{2(g)} = 2\ ClO_{2(g)} + 2\ NaCl \qquad [1]$$

The chlorine dioxide generator will use ~25 percent chlorite solutions and the onsite gaseous chlorine. To minimize dilution effects, the chlorine dioxide generators will be operated under an "intermittent batch" mode. The generator will produce a high concentration of chlorine dioxide solution rather than a continuous stream of low concentration chlorine dioxide solution. The chlorine dioxide stock solution will be stored in a "day" tank where a metering pump will inject the chlorine dioxide into the Maerkle Reservoir influent water. The "day" tank will be cycled at least daily to avoid long-term (greater than 24 hour periods) storage of the stock solution.

The generation equipment and day tank (a contiguous unit) will be placed in the chlorine injection room (Figure 1). The chlorine dioxide will be injected at the existing chlorine injection point (Figure 2).

Figure 1. Chlorine injection room is adjacent to the chlorine storage facility.

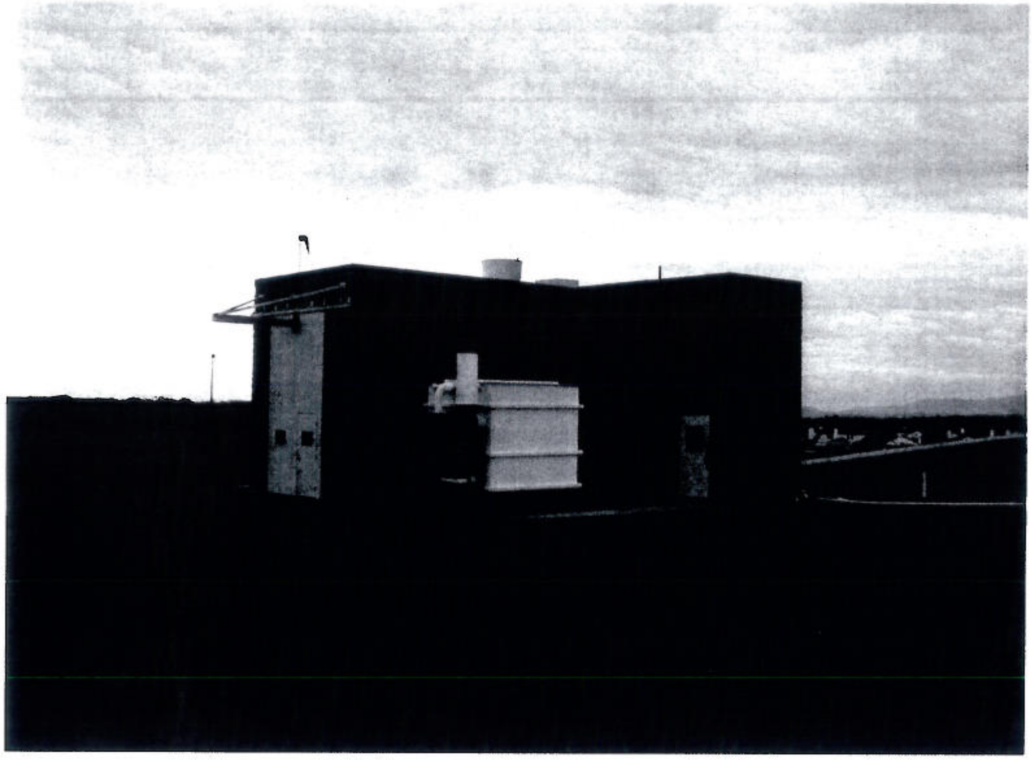


Figure 2. The chlorine dioxide will be injected at the existing chlorine injection point.

III. OPERATING PLAN

The CMWD Maerkle Reservoir Operations Plan is attached in Appendix A. Mr. Jim Ball is Supervisor of Water Operations and will directly supervise operations at Maerkle Reservoir and the five CMWD operators who operate the Maerkle system. Appendix B contains operator number, certification, and grade information for these operators. The Reservoir will be operated as steadily as possible under the Mode #3 operating scenario during this investigation. Jim Ball and Mr. Kurt Musser, the Public Works Manager will make decisions regarding changes in flow into and out of the Reservoir and changes in valve settings. The reservoir influent flow will be held constant at 3 cubic feet per second (CFS). The storage volume in the reservoir will be held relatively constant at approximately 110 million gallons, which is the minimum storage in Maerkle Reservoir. Due to the limited staffing available during the weekends, Maerkle Reservoir will be isolated by closing Valves 6 (normally closed, NC) and 18 on the Maerkle influent and Valves 15 (NC) and 16 on the Maerkle effluent (see valve diagram in Section III), and shutting off the chlorine dioxide feed. Maerkle Reservoir effluent will not be delivered into the distribution system from Friday afternoon at 5 PM to the following Monday morning at 8 AM.

The chlorine dioxide feed will be paced off of the reservoir influent flow meter. The goal will be to feed chlorine dioxide at a dose that results in a chlorite residual of approximately 0.5 mg/L as chlorite, which is 50% of the chlorite MCL. After 3 months into this investigation, if Maerkle exhibits no signs of nitrification (i.e., nitrite < 0.005 mg/L), the chlorine dioxide dose will be decreased to a level that results in a chlorite level of approximately 0.2 mg/L. This approach was chosen over a stepping-up approach (i.e., start at 0.2 mg/L chlorite and step up to 0.5 mg/L chlorite if Maerkle Reservoir begins to nitrify) because it will be much more difficult to control and remedy a nitrification episode once it has started. Furthermore, higher levels of chlorite would be more effective during the priming period due to dilution and blending with existing water in storage. It is important to note that the reservoir effluent will be blended with fresh water directed off the TAP pipeline at a minimum of 2:1 ratio in the 10 MG reservoir (see Section III). Therefore the actual level of chlorite entering the distribution system will be significantly less than the target levels.

IV. SAFETY CONSIDERATIONS

In addition to the storage and use of chlorine gas, which CMWD is currently practicing and has protocols for operating, the following additional considerations will be addressed.

Aqueous Sodium Chlorite Storage

Sodium chlorite solutions typically used for chlorine dioxide generation have a concentration of 25 – 32 % (w/w). Sodium chlorite solutions react with acids, oxidizers, and reductants and must be stored separately from chlorine gas. Solutions of sodium chlorite also will be prevented from crystallizing or drying out, because the white precipitate is explosive if exposed to heat or flame. Excessive high temperatures and exposure to sunlight or UV radiation will be avoided. Secondary containment will be provided for the sodium chlorite storage tank and MSDS will be consulted and available (see Appendix C).

Chlorine Dioxide Generation

Pure solutions of chlorine dioxide of moderate concentrations (< 4 g/L) and at neutral pH values are less corrosive than aqueous chlorine supplies they typically replace. It is anticipated that solutions of approximately 1500 mg/L will be generated and stored. Generator manufacturer guidelines will be followed.

Aqueous Chlorine Dioxide Storage

Solutions of chlorine dioxide less than 5 g/L are generally very stable if stored at moderate temperatures and in the dark. Off-gassing and excessive pressure, excessive heat, sparks, and flames will be avoided during storage of chlorine dioxide solutions. Secondary containment will be provided for the chlorine dioxide storage tank and MSDS will be consulted and available (see Appendix C).

Chlorine Dioxide Generation

A skid-mounted, two-chemical chlorine dioxide (ClO_2) generator is being provided by Vulcan Performance Chemicals for this demonstration. The details of the chlorine dioxide generation process and the safety features of the chlorine dioxide generator are provided below.

General

Chlorine dioxide feed equipment shall be as manufactured by VULCAN PERFORMANCE CHEMICALS and shall be comprised of a Process for chlorine dioxide generation utilizing sodium chlorite solution and chlorine gas. The sodium chlorite solution shall be a 25 percent by weight solution.

The feed system shall be capable of producing 30 pounds per day (0.57 kg/hr) of chlorine dioxide.

The generator shall maintain a minimum yield efficiency of 95 percent chlorine dioxide from the reaction of chlorine and sodium chlorite. The yield efficiency shall be based on the stoichiometric reaction as follows:

$$2\ NaClO_2 + Cl_2 \text{ --------> } 2\ ClO_2 + 2\ NaCl$$

The chlorine dioxide generation equipment shall maintain the specified minimum yield efficiency of 95 percent over a 5 to 1 feed range based upon the maximum capacity of the generator.

The reaction of chlorine gas and sodium chlorite to form chlorine dioxide shall take place under vacuum and shall be achieved without the use of a separate mineral acid feed or without the excess chlorine feed method (adding chlorine in excess of the stoichiometric chlorine requirement in order to lower the process pH). Excess chlorine feed shall be considered as any amount greater than 5 percent (%) of the chlorine feed that remains in the generator product as unreacted chlorine.

Yield Determination Analysis

The minimum yield of 95 percent chlorine dioxide from the reaction of the two specified chemicals shall be as a minimum. Yield shall be defined as the ratio of chlorine dioxide generated to the theoretical stoichiometric maximum.

The yield will be demonstrated by an amperometric analysis capable of differentiating between chlorine, chlorine dioxide, chlorite and chlorate. Analysis shall be confirmed by the procedure written by Marco Aieta, et al in the JAWWA, Volume 76, January 1984, page 64, Determination of Chlorine Dioxide, Chlorine, Chlorite and Chlorate in Water, also AWWA Standard Method 4500-ClO_2 E. Amperometric Method II. The theoretical stoichiometric maximum shall be determined from the feed rates of the two reacting chemicals.

The system will not be released to the owner until the yield is confirmed.

Chlorine Dioxide Generation Method

Chlorine dioxide shall be produced by reacting gaseous chlorine directly with a liquid solution (25 percent) of sodium chlorite. The reaction shall be assisted with a water-operated ejector included with the generation equipment. Chlorine dioxide shall result from the complete reaction of the chlorine gas and sodium chlorite in a reaction column prior to dilution with water.

The reaction shall be controlled by the metering of the sodium chlorite reactant through a flow-control valve and the metering of the chlorine gas through a flow-control valve. The feed ratios of the two reactants shall be maintained as given in the stoichiometric equation in Paragraph 1. Both flow control valves are to be included with the generation equipment, and shall measure flow as 0-100% for chlorite and lbs/day (or kg/hr) for chlorine. Water to the ejector will be metered with a flowmeter capable of measuring water flow to the nearest 1.0 liter/minute. The driving force for metering the reactants shall originate at the water-operated ejector that creates the necessary vacuum conditions. The two chemicals shall react nearly instantaneously in a reactor column or vessel creating chlorine dioxide at high yield efficiency. The water used at the water ejector (which created the vacuum) shall also dissolve the chlorine dioxide gas in the ejector water stream for delivery to the batch tank at concentrations between 200 and 3300 mg/l. The pH of the generator effluent may range between 6.7 and 7.0, it shall not, however, fall below 6.0. A sampling port shall be available where the chlorine dioxide solution exits the generator.

Generator Panel

The panel containing all generation equipment shall be mounted on a frame comprised and part of the batch system and shall be constructed of fiberglass reinforced plastic (FRP). All materials in contact with chlorine dioxide shall be constructed of FRP, glass, PVC or non-corrosive metal. All piping, materials and valves exposed to chlorine gas (under vacuum conditions); sodium chlorite solution piping and valves) and chlorine dioxide solution piping and valves shall be constructed of schedule 80 PVC, CPVC or Teflon. Piping shall be furnished with sufficient unions to permit easy assembly and disassembly. All shutoff valves shall be true union ball valves.

Chlorinator

The Chlorinator shall be dedicated to the chlorine dioxide generator and shall be a wall mounted or ton container mounted, vacuum operated, solution feed type with a capacity of 0 to 20 lb/day (0.37 kg/hr) of chlorine gas and shall manually regulate chlorine gas feed rate.

The chlorinator shall be designed to insure maximum safety for operating personnel. The chlorine gas control system shall operate under vacuum to prevent gas leakage. The chlorinator shall be designed for simplicity of installation and maintenance.

The chlorinator shall contain a positive acting chlorine gas shutoff valve, a diaphragm operated pressure relief valve and an excess vacuum shutoff valve. An indicator shall provide a visual signal when chlorine gas supply is exhausted or interrupted. When specified, the chlorinator shall be furnished with automatic changeover function through the use of a second vacuum regulator.

Each regulator shall indicate whether it is in "Reserve", "Operating" or "No Gas" condition. The changeover system shall not require the use of an external valve. When specified, an out-of-gas switch contact kit shall be provided. The chlorine supply shall not have any air-bleed type vacuum limiting devices.

A flowmeter shall be provided to indicate chlorine gas flow rate and shall be mounted on the chlorine dioxide generator panel. The flowmeter shall be provided with its own rate valve and shall have a scale in English units. Accuracy of the chlorine feed shall be plus or minus 4 percent of the set rate over a 20:1 range.

The chlorinator shall be constructed entirely of materials resistant to the corrosive attack of chlorine gas and shall be designed for cylinder or ton container mounting.

Batch System

The batch tank that receives the chlorine dioxide solution from the generation system shall be constructed of fiberglass-reinforced plastic with a covering device that will contain fittings to allow for low pressure venting of chlorine dioxide vapors either to a scrubbing device or the atmosphere above and out of the installation site.

The batch tank will contain a four-position positive float system for generator and distribution system control:

a. Hi-Hi Safety Control to turn off generator in the event of Hi-Control failure.

b. Hi-Control to turn off generator when the level of chlorine dioxide solution is suitable for distribution by the chlorine dioxide distribution system.

c. Lo-Control to turn on generator when batch tank does not have suitable level of chlorine dioxide solution, i.e. refill signal.

d. Lo-Lo Safety Control to turn off generator and chlorine dioxide distribution system in the event of Lo-Control failure.

In addition, the batch tank will have a completely independent float system backing up the Hi-Hi Safety Control.

Batch Distribution System

The Batch Distribution System shall provide chlorine dioxide solution to the point of application utilizing a magnetically coupled centrifugal pump sized to meet the needs of the system. Flow control shall be through a manual flow valve and rotameter. A by-pass shall allow for consistent pump operation.

Alarms and Shutdown Procedures

The chlorine dioxide generation system shall automatically shut down (or initiate alarm and cross-over sequencing) and provide both local and remote alarms under the following circumstances:

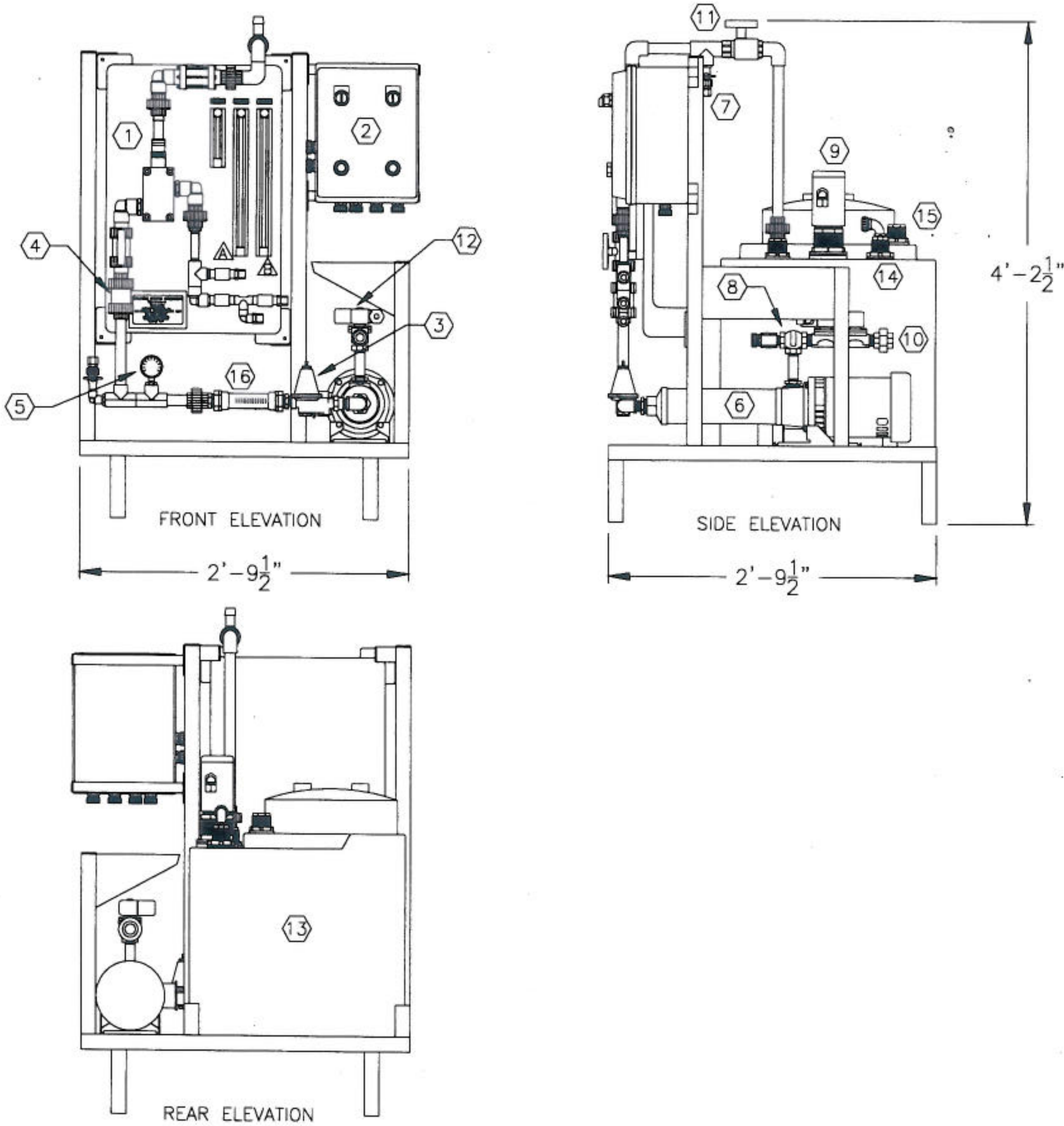
a. No sodium chlorite solution. A level switch in the sodium chlorite solution storage tank shall activate this alarm.

b. No chlorine gas. A vacuum switch in the chlorine gas supply line shall activate this alarm.

c. Loss of ejector water flow. A flow switch in the generator water supply line shall activate this alarm.

d. General generator failure

Generator Schematic



LEGEND

1. ClO_2 GENERATOR
2. CONTROL BOX
3. PRESSURE REGULATOR
4. INCOMING WATER CHECK VALVE
5. PRESSURE GAUGE
6. BOOSTER PUMP
7. ClO_2 SOLUTION SAMPLE POINT
8. FLOW SWITCH
9. LEVEL CONTROL SYSTEM
10. INCOMING WATER SUPPLY
11. ClO_2 SOLUTION BALL VALVE
12. WATER SOLENOID VALVE
13. 30 GALLON BATCH TANK
14. SAFETY HI/HI LEVEL SWITCH
15. 1" VENT
16. INCOMING WATER FLOWMETER

NOTES:

1. CUSTOMER SUPPLIES CHEMICAL FEED TO POINTS A AND B.

REVISIONS		
NO.	DATE	BY
1		
2		
3		
4		
5		

Vulcan CHEMICAL TECHNOLOGIES, INC.

C-30L-CMD
GENERAL ARRANGEMENT

DRAWN BY D. WOLFE	SCALE 1"=1'-0"	MODEL C-30L-CMD
CHK'D	DATE 11-9-99	DRAWING NUMBER C3MD-S
SERIAL NO.	APP'D	

VI. MONITORING PLAN

Chlorine Dioxide Generator and Stock Solution

The chlorine dioxide generator feed rate (chlorine and sodium chlorite) will be visually inspected daily to ensure the generator is producing the intended concentration of stock solution with high purity. In addition, the chlorine dioxide concentration in the "day" tank will be monitored weekly.

Monitoring at Maerkle Reservoir

Per the provisions of the Stage 1 D/DBP Rule, CMWD will be monitoring for chlorine dioxide residual and chlorite. As a part of the nitrification control monitoring, total chlorine, nitrite, total ammonia, and HPCs will be sampled. Table 1 is a detailed outline of the monitored constituents, monitoring frequencies and analytical methods to be used for this investigation:

Table 1. Outline of required monitoring.

Constituents	Frequency	Method
Maerkle Reservoir Effluent		
Flow	Continuous	In-line Meter
Total Chlorine Residual	Continuous	Hach On-line Analyzer (colorimetric DPD)
Chlorine Dioxide Residual	Daily	Standard Method 4500-E
Chlorite	Daily	Standard Method 4500-E
Nitrite	Weekly	Diazotization: Hach Method 8507
Total Ammonia	Weekly	Salicylate: Hach Method 8155
HPC	Weekly	Pour Plate Method
Carlsbad Distribution System		
3-Sample Set for Chlorite and Chlorate	Monthly	EPA Method 300.0 or 300.1
Total Chlorine	Part of Routine Total Coliform Monitoring	Hach Method 8167 (DPD)

The flow measurements will be taken from the meter located on the reservoir influent line. All other constituents will be measured at the reservoir effluent. Reservoir effluent samples will be collected at the lower disinfection monitoring facility (see chlorine residual analyzer station on diagram in Appendix A). A sample tap will be installed on the feed line to the reservoir effluent chlorine analyzer, which is prior to blending.

Distribution System Monitoring

CMWD will be monitoring for chlorite and chlorate at 3 sampling locations that best represent: 1) nearest to first customer, 2) average detention time and 3) maximum detention time. Table 2 shows the locations where these samples will be collected. These sampling locations are also CMWD's Stage 1 trihalomethane and haloacetic acid monitoring sites.

Table 2. Distribution system chlorite and chlorate sampling locations ("3-Sample Set").

Nearest First Customer	Madonna Hill
Average Detention Time	2728 Athens
Maximum Detention Time	3960 Garfield

The total chlorine residual collected during routine total coliform monitoring for all distribution system monitoring locations will be evaluated monthly for signs of nitrification.

Analytical Laboratory

Samples from daily chlorite monitoring and samples from monthly chlorite monitoring in the distribution system require analysis at a California Department of Health Services ELAP certified laboratory. Currently, there are no ELAP certified contract laboratories in San Diego County that perform these three analyses. CMWD has contacted their standard contract laboratory, Environmental Engineering Laboratory in San Diego, to inquire if they would obtain certification for any of these analyses. Environmental Engineering Labs has stated they intend to have certification for chlorite analysis using the IC method. Chlorite samples to be analyzed using this method can be stabilized and stored for 14 days; therefore, other labs in Southern California may be utilized if necessary for distribution system samples and confirmation samples. CMWD will utilize an approved method on-site for chlorine dioxide analysis (Standard Method 4500-ClO_2 D). CMWD, in the future, intends to purchase an amperometric titrator for on-site (real-time) analysis, which may be used for daily samples of both chlorine dioxide and chlorite, and seek approval to use this method pending ELAP certification by the state. CMWD will prepare a separate SOP for conducting these analyses that will address basic use of the equipment and QA/QC protocols, including replicate analysis and split samples for confirmation analysis using other methods. In the interim, CMWD will use an ELAP certified laboratory for chlorite analysis. CMWD intends to work with DHS to obtain satisfactory analyses for daily monitoring of chlorine dioxide and chlorite.

VII. RESPONSE PLAN

The strategy of this investigation is to use the synergistic effects of chlorine dioxide and chlorite to prevent nitrification from taking place in Maerkle Reservoir once current breakpoint operations are discontinued. The target chlorine dioxide dose is approximately 0.6 mg/L to 0.3 mg/L, which should result in a chlorite level of 0.5 to 0.2 mg/L. The typical degree of chlorine dioxide to chlorite conversion is 70%. The following section outlines the response procedures should the chlorine dioxide or chlorite levels exceed target levels or if Maerkle Reservoir exhibits signs of nitrification.

Chlorine Dioxide Residual Monitoring

If the chlorine dioxide (ClO_2) residual in the reservoir effluent water (prior to blending) exceeds 0.64 mg/L (80% of the MRDL), follow the action flow diagram in Figure 4.

Chlorite Monitoring

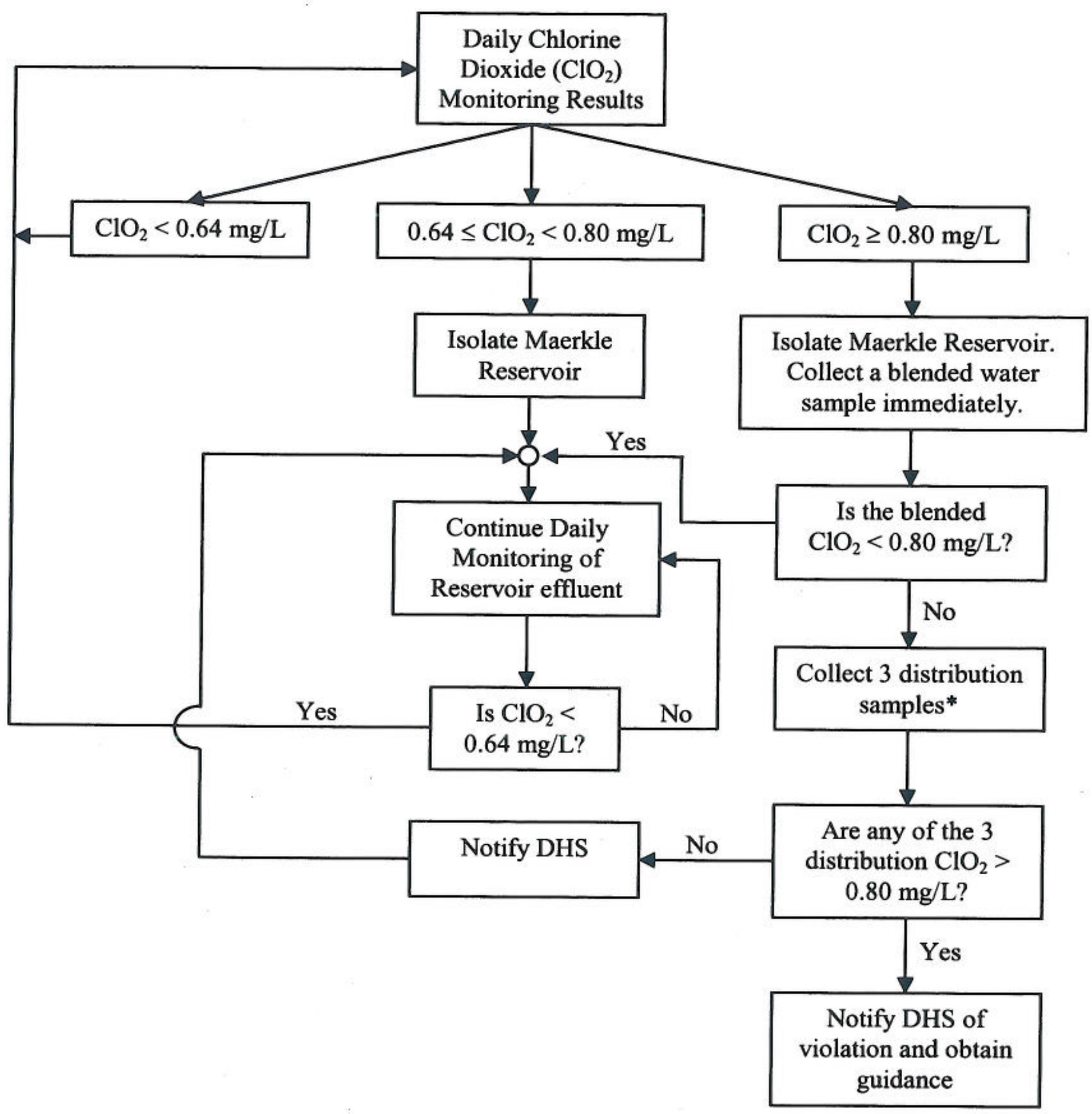
If the daily chlorite level in the reservoir effluent water (prior to blending) exceeds 0.8 mg/L (80% of the MCL), follow the action flow diagram in Figure 5.

Nitrite Monitoring

If the weekly nitrite level in the reservoir effluent water (prior to blending) exceeds 0.010 mg/L, follow the action flow diagram in Figure 6.

HPC Monitoring

If the weekly HPC level in the reservoir effluent water (prior to blending) exceeds 500 colony-forming units (CFU), follow the action flow diagram in Figure 7.



* The samples will be collected at the Madonna Hill (nearest first customer) sampling site at 6-hour intervals (e.g., 6-, 12-, and 18-hours).

Figure 4. Chlorine dioxide (ClO_2) action flow diagram.

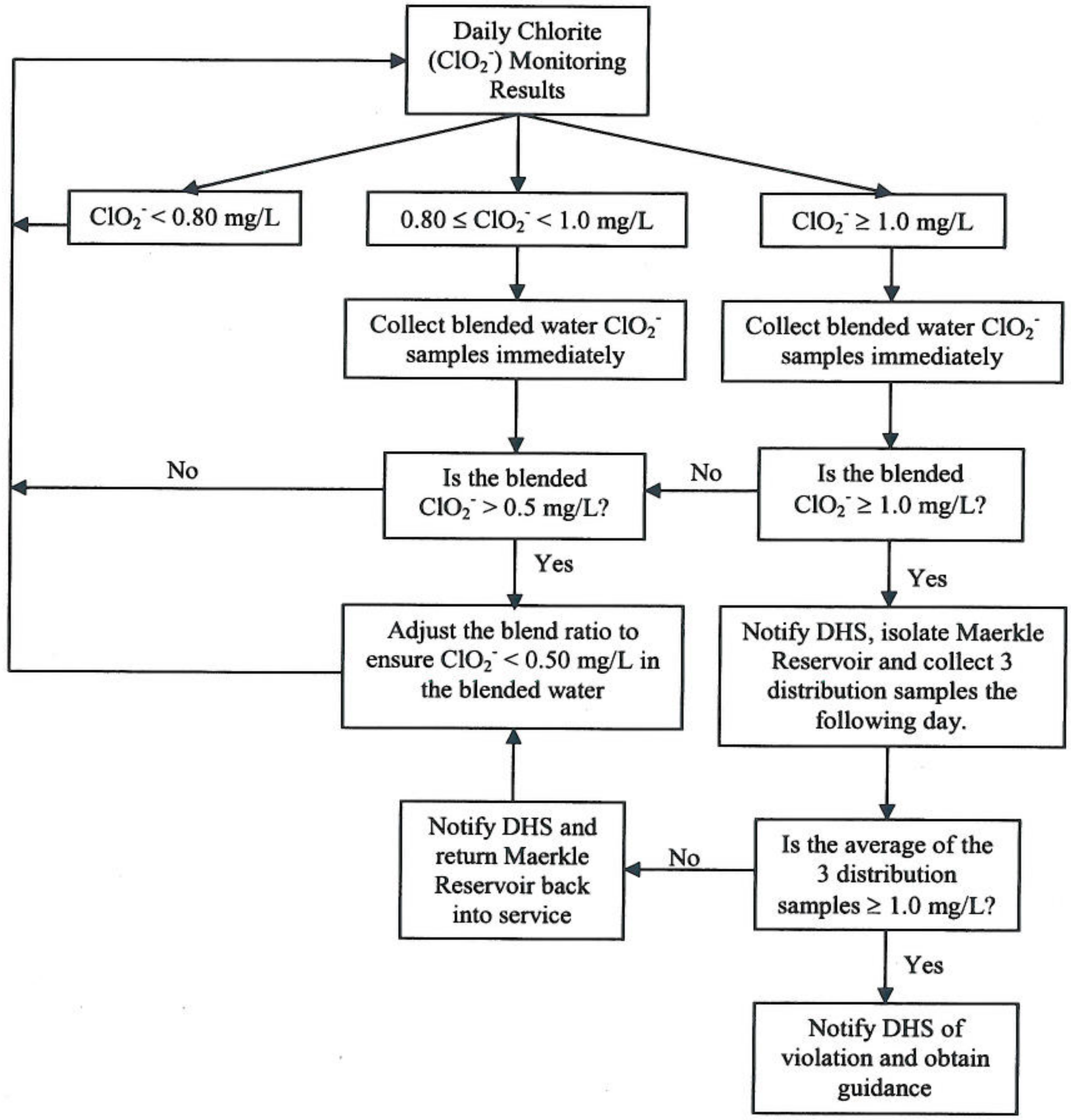


Figure 5. Chlorite (ClO_2^-) action flow diagram.

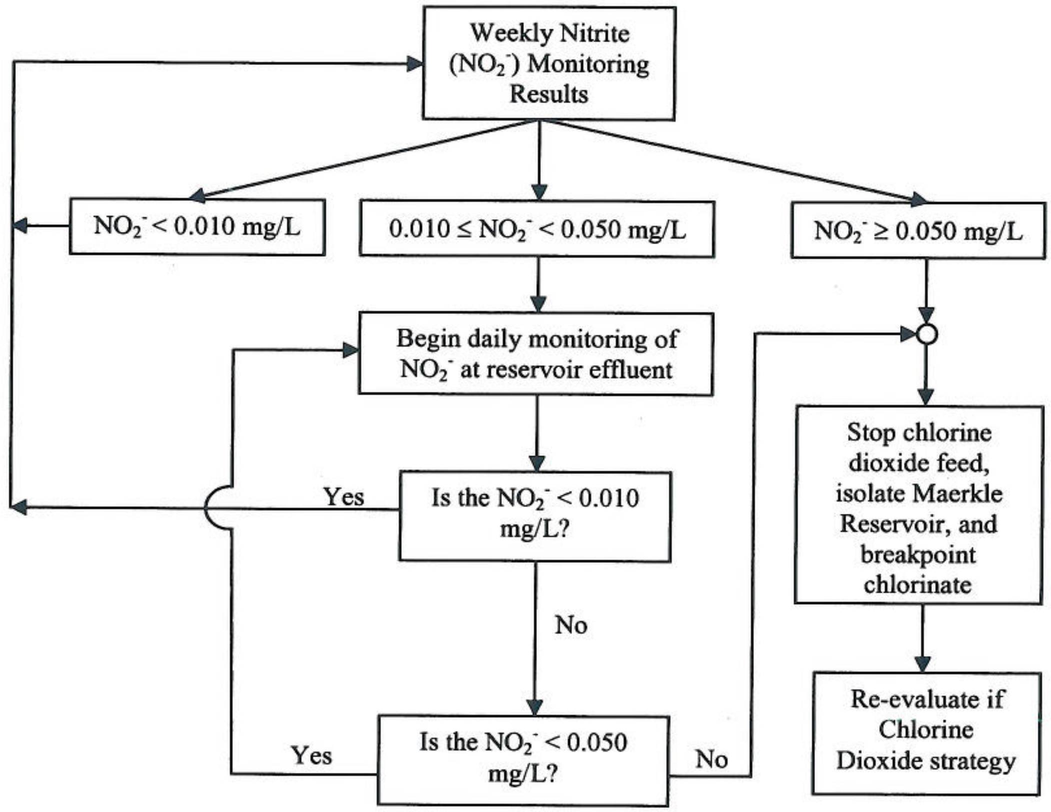


Figure 6. Nitrite (NO_2^-) action flow diagram.

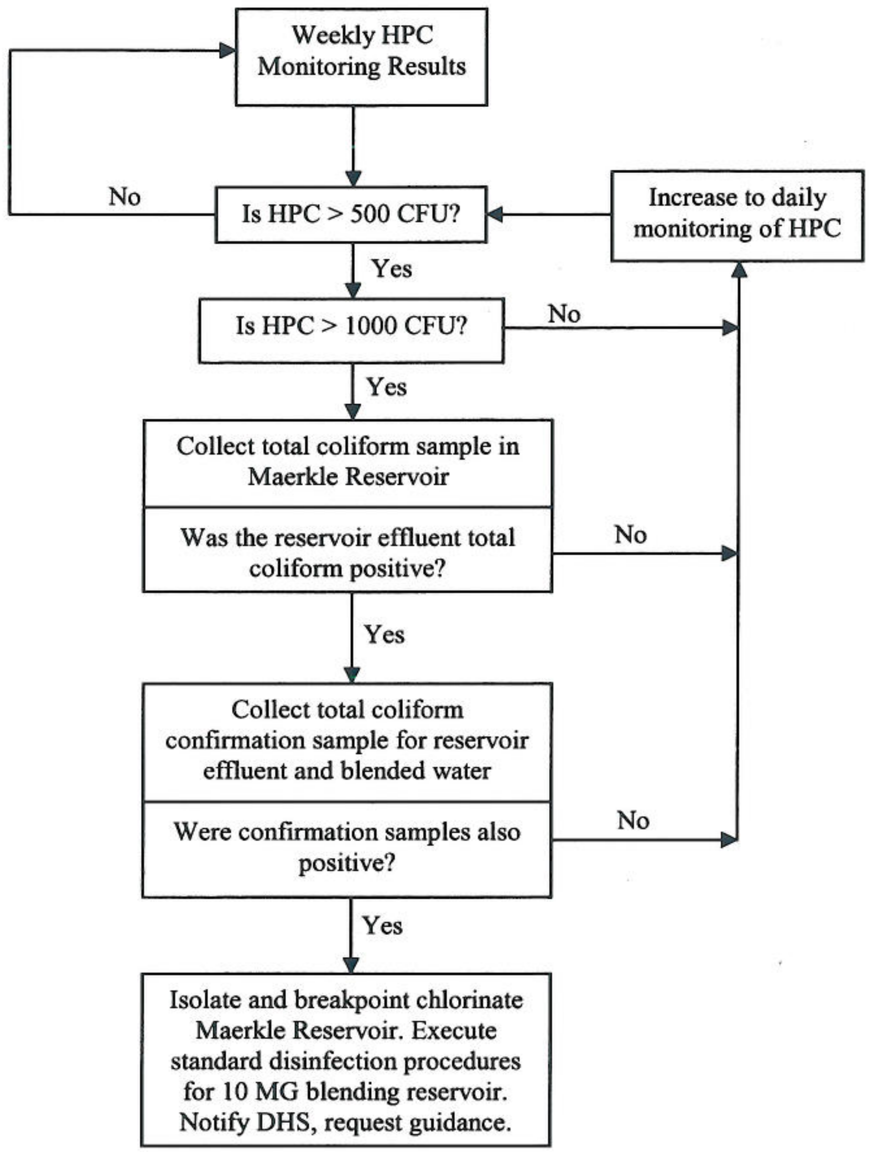
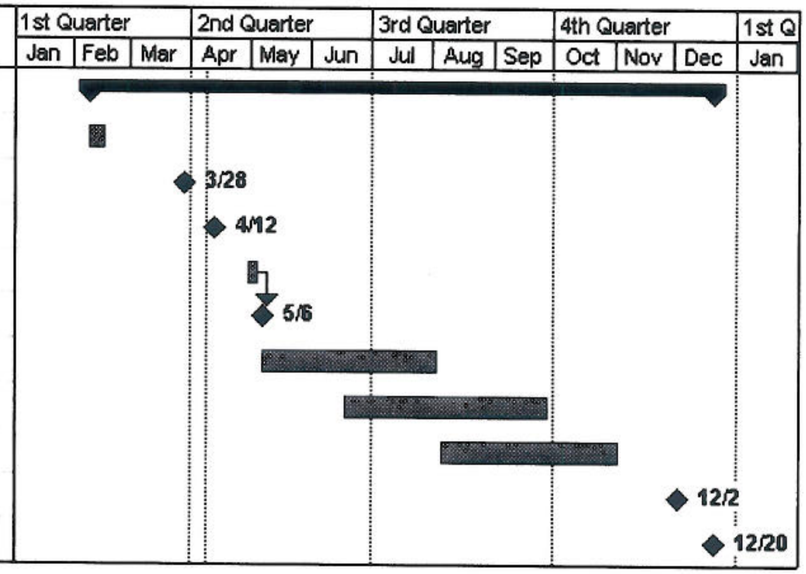


Figure 7. HPC action flow diagram.

VIII. SCHEDULE

ID	Task Name
1	**Use of Chlorine Dioxide to Inhibit Nitrification in Maerkle Reservoir**
2	Submit Draft Proposal to DHS
3	Conceptual Presentation to DHS
4	Permit Amendment Application to DHS
5	Deliver and Install Chlorine Dioxide Equipment
6	Begin Testing
7	Monitor Phase 1
8	Phase 2 - Evaluate Results and Modify Chlorine Dioxide Feed
9	Phase 3 - Evaluate Results and Modify Chlorine Dioxide Results
10	Draft Report
11	Final Report



Note: Tentative planning schedule. Actual Start Date will be based on approval from Department of Health Services.

Appendix A – Maerkle Reservoir Operations Plan

MAERKLE RESERVOIR OPERATIONS PLAN

THE SITE

The Maerkle Facility is a 111 acre site that consists of a ten million gallon distribution reservoir, a 600 acre foot long term storage impound, one pumping/disinfection facility, one impound disinfection facility, related pressure control stations, meter stations, and a caretakers residence. The water supply to this facility is via the Carlsbad #3 connection with the San Diego County Water Authority. The meter connection is sized for 2 to 20 c.f.s. and feeds through the pressure sustaining station located just west of the distribution reservoir.

FACILITIES

1 - Ten million gallon rectangular reservoir. Concrete construction with baffle walls.

1 - 600 Acre foot dam (impound) asphalt lined and polypropylene covered.

1 - Pump and disinfection station with a 2,000lb/day capacity (scrubber protected).

1 - Impound disinfection station with a 2,000lb/day capacity (scrubber protected).

2 - Pressure sustaining stations.

1 - Flow metering vault.

1 - Chlorine analyzer room.

OPERATIONS PLAN

There are five basic modes of operations for this facility. Mode 1 is for the aqueduct connection to feed the distribution reservoir with trim chlorination when required. Mode 2 allows the use of Maerkle dam as the primary source of water. This occurs when M.W.D. is off line or M.W.D. water is directed to the back of the dam. Effluent from the dam is chloraminated and pumped to the distribution reservoir. Mode 3 is the normal mode of operation. Mode 3 occurs when water from M.W.D. and Maerkle dam are blended in the ten million gallon reservoir. Mode 4 is a re-circulating process that is accomplished when free chlorinated water is pumped back to the dam. The dam can also be used to feed free chlorinated water directly to the distribution system (Mode 5), if necessary. Refer to Figure 3 on page 5 for valve locations refereed to in the mode descriptions.

MODE 1 (M.W.D. Water)

This mode is chloraminated water from M.W.D. The ten million gallon reservoir supplies water to the distribution system and serves as a floating head. The flow can be in or out of the reservoir depending on demand.
Free and total chlorine residual analyzers and sampling points are located at Maerkle's lower chlorine residual analyzer facility (see diagram). Disinfection and alarm set points are monitored via Water Operation's SCADA system.

MODE 1 Operation

Carlsbad #3 on line

Normally Open	**Normally Closed**
V-3	V-1
V-4	V-2
V-5	V-6
V-8	V-7
V-9	V-10
V-11	V-13
V-12	V-15
V-14	V-18
V-16	
V-17	
V-19	

When desired, part or all of the flow may be diverted into the dam by opening V-18 and flowing through an 8" sustaining valve. Water diverted to the dam is breakpoint chlorinated using Maerkle's upper chlorine facility.

MODE 2 (Maerkle Dam Water)

This system pumps and chloraminates water from the effluent of Maerkle dam to the 10 million gallon reservoir. The ten million gallon reservoir supplies water to the distribution system and serves as a floating head. Chlorination and or ammoniation control, from Maerkle's lower chlorination/ammoniation facility, is flow paced only. Pumping, disinfection and alarm set points are monitored via Water Operation's SCADA system. This mode can be used when M.W.D. water is not available or when all M.W.D. water is directed to the back of the dam. (see diagram)

MODE 2 Operation

A. Pump 1, 2, 3 or 4 on line.
B. Flow Paced Chloramination on line.

Normally Open	Normally Closed
V-3	V-1
V-4	V-2
V-5	V-6
V-8	V-7
V-9	V-10
V-11	V-13
V-12	V-15
V-14	V-18
V-16	
V-17	

MODE 3 (M.W.D./Maerkle Dam Blend)

This is the primary system in use. Chloraminated water from M.W.D and chloraminated water pumped from the effluent of Maerkle dam is blended in the 10 million gallon reservoir. Blending of M.W.D. and Maerkle dam waters is maintained at a ratio of 2:1 or greater. The ten million gallon reservoir supplies water to the distribution system and serves as a floating head.

MODE 3 Operation

Normally Open	**Normally Closed**
V-3	V-1
V-4	V-2
V-5	V-6
V-8	V-7
V-9	V-10
V-11	V-13
V-12	V-15
V-14	V-18
V-16	
V-17	

MODE 4

This system is designed to re-circulate free chlorinated or chloraminated water, as desired by the District, back to the dam. To re-circulate water, open V-7 and close V-5.

MODE 4 Operation

A. Pump 1, 2, 3 or 4 on line

Normally Open	**Normally Closed**
V-3	V-1
V-4	V-2
V-7	V-6
V-8	V-5
V-9	V-10
V-11	V-13
V-12	V-15
V-14	V-18
V-16	
V-17	

MODE 5

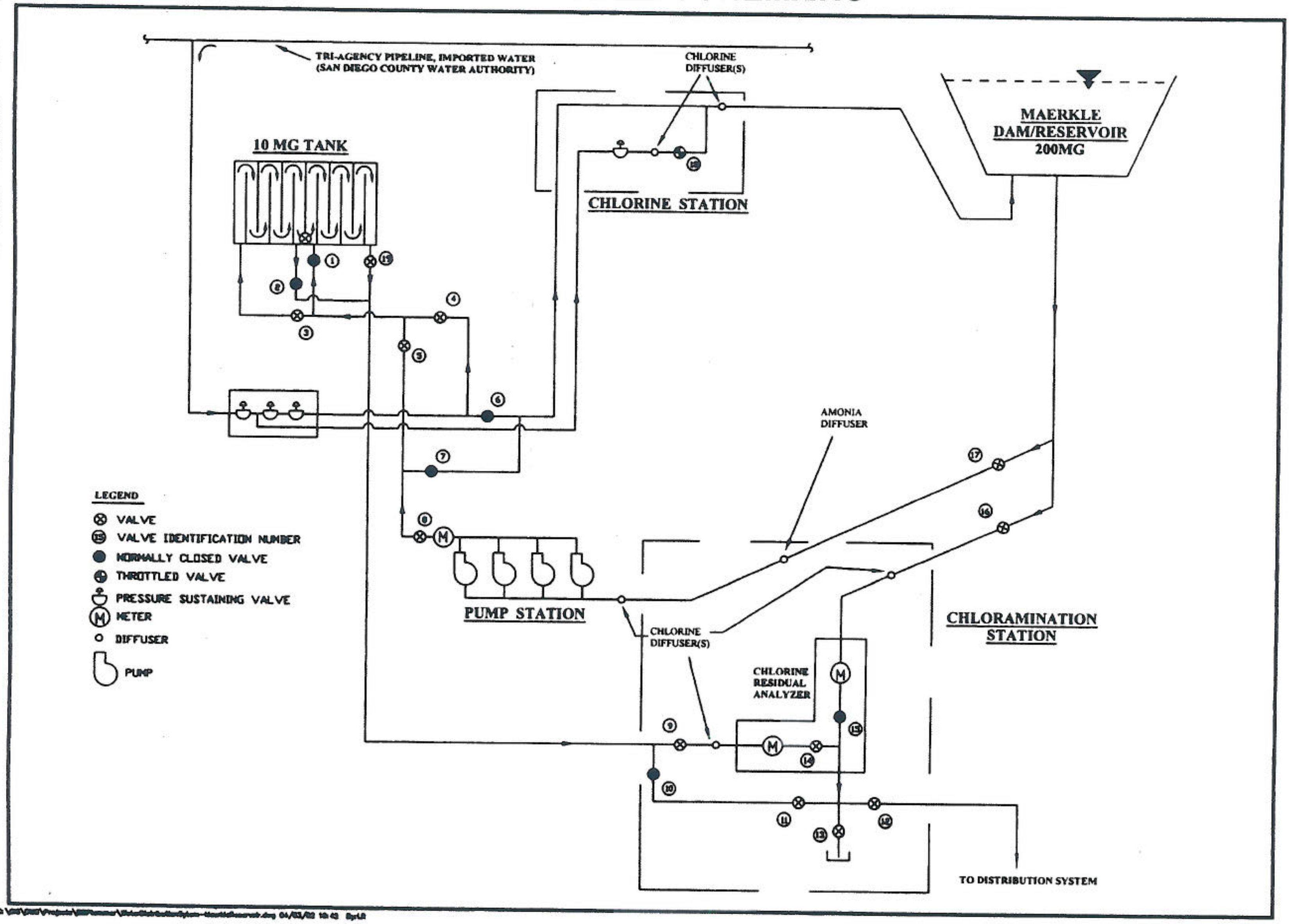
This system is used when the dam is directly supplying the water system as a floating head. The flow can be in or out of the dam depending on demand. This system is free chlorine only. Chlorination is controlled via compound loop (flow and residual).

This operation is accomplished when V-15 is opened and V-16 is closed. All other valves remain in the normally opened or closed position. Flow is controlled through Maerkle Control valve.

CONTINGENCY PLAN

All modes are easily controlled via valve changes (see diagram). Disinfection process and pump operations are monitored via Water Operation's SCADA system and daily site checks and water quality testing is performed. In Mode 2 or 3, if a disruption or change in the disinfection process in the effluent of Maerkle Dam or pump operation occurs, Water Operations will respond immediately. Maerkle Dam will be isolated from the system by shutting down pumps and the disinfection process. Operation of this process will not resume until the problem has been corrected.

MAERKLE SCHEMATIC



Appendix B – CMWD Operator Information

Name	Certification	Grade	Operator Number	Renewal/ Expiration	Submit Application Max 180 day Notice
Jim Ball	AWWA	3	2533	12/31/03	Per Notice
	DOHS	T 3	9838	3/1/04	9/1/03
	DOHS	D 5	2533	2/1/05	1/0/00
Joe Adams	AWWA	3	3639	3/31/04	Per Notice
	DOHS	T 2	13161	3/1/04	9/1/03
	DOHS	D 4	3639	8/1/03	2/2/03
Paul Farley	AWWA	3	4011	7/31/02	Per Notice
	DOHS	T 2	13536	3/1/04	9/1/03
	DOHS	D 4	4011	8/1/03	2/2/03
Rene Hailey	AWWA	3	3642	12/31/03	Per Notice
	DOHS	T 2	12933	11/1/04	5/1/04
	DOHS	D 4	3642	8/1/03	2/2/03
Tom Pagakis	AWWA	2	5043	1/31/04	
	DOHS	T 2	16306	12/1/04	6/1/04
	DOHS	D 3	5043	8/1/03	2/2/03
Ron Oreb	AWWA	3	7289	8/31/02	Per Notice
	DOHS	T 2	20144	5/1/04	11/1/03
	DOHS	D4	7289	8/1/03	2/2/03

CA DOHS Certification: 916-327-1139
AWWA Certification: 909-481-7200
Certificates that expire on 1/1/04 or later require continuing education to renew.
Any person wishing to maintain a valid operator certificate shall submit an application for renewal at least 120 days, but no more than 180 days, prior to expiration of the certification.

Appendix C – Equipment List

Flow Control

Flowmeter installed on Maerkle influent line where chlorine dioxide is fed
Isolation valves for Maerkle inlet (Valves 6 and 18)
Isolation valves for Maerkle outlet (Valves 15 and 17)

Chlorine Dioxide Generation

Chlorine dioxide generator (Vulcan, Model C-30L-CMD), composed of:

- Sodium chlorite storage tank containing 25 – 31% sodium chlorite solution (Vulcan)
- Existing chlorine gas feed (Jones)
- Existing make-up water

Day storage tank for chlorine dioxide with level sensor
Metering pump for chlorine dioxide

Monitoring

Amperometric Titrator with Platinum-Platinum electrode (Fisher Cl Titrimeter System or equivalent)
Chemicals for titration (phenylarsine oxide, potassium iodide, pH buffers)
Dedicated glassware for titration
Online total chlorine analyzer (Hach CL17 or equivalent)
Handheld spectrophotometer (Hach DR/890 or equivalent)
Hach powder pillows for chlorine dioxide, ammonia, and nitrite

Appendix D – Material Safety Data Sheets and NSF Certification

Chlorine Gas – Jones

NSF Certification – Jones

Sodium Chlorite – Vulcan

NSF Certification – Vulcan

Chlorine Dioxide – Generated On-Site

Carlsbad Municipal Water District

2010 Water Master Plan

<u>TECHNICAL MEMORANDUM NO. 1</u>

Data Quality

December 2009

Prepared For:

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Prepared By:

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TECHNICAL MEMORANDUM NO. 1
Data Quality
December 2009

INTRODUCTION

The following Technical Memorandum (TM) was prepared for the Carlsbad Municipal Water District (CMWD) as part of the 2010 Water Master Plan. These TMs serve as an interim submittal for CMWD review and comment as they contain report information, as well as the additional background information used to develop the report sections. The purpose of this Technical Memorandum No. 1 is to summarize the technical data received from CMWD in preparation of the Water Master Plan and document any significant data gaps that may affect the modeling and study efforts. In addition, based on the data received for the water model, this TM summarizes the quality of the data and the potential effect or impact this data could have on the accuracy of the updated H_2OMAP model. Data quality summaries are noted in italics throughout the TM.

CONTENTS

<u>System Facility Information</u> – The following is based on information received from CMWD on April 30, 2009 regarding the water system facilities.

- Emergency Inter-Agency Connections – Electronic and hard copy data was provided for 12 emergency inter-agency connections. The data was provided in a table that included the source agency, a general location, pressure zones within CMWD, atlas map page, and Thomas Brothers Guide page for each emergency connection. Four connections included a flow rate. However, it is unknown if these flow rates are contractual or actual uses. Status of these emergency inter-agency connections (active or inactive) was not provided. *This data is not critical to the model unless these are active connections that are used on a regular basis.*
- Normally-Closed Valves – Electronic and hard copy information was provided for 70 normally closed valves. This data includes a general location, upstream and downstream pressure zone, atlas map page, and Thomas Brothers Guide page. *This data is necessary to determine pressure zone boundaries in the model. Some zone boundaries may have been changed since the last Master Plan, and through model calibration, additional boundary adjustments or the identification of additional closed valves are likely to be made.*
- Pump Stations – Information was provided for 4 pump stations (Maerkle, Buena Vista, Bressi, and Calavera Hills Pump Stations.) The electronic information received includes the pump and motor manufacturers and capacity, horsepower, rpm, and amps for each pump unit. A general location along with atlas and Thomas Brothers Guide pages are also included. Additional hard copy information was provided for the Buena Vista and Ellery Pump Stations, as noted below. No pump curves were provided.
    - Buena Vista Pump Station – Additional data included a site plan of the stations, motor control diagram, single-line electrical diagram, pump and motor specifications, manufacturer cut sheets and installation instructions.

- Ellery Pump Station – Additional data included pump and motor specifications, manufacturer cut sheets and installation instructions.

Currently these pump station facilities are not normally in use and are not included in the District's hydraulic water model. PBS&J would normally request pump curve data if these pumping units were to be added to the model. But since modeling emergency back pump scenarios (in the event of a CWA Aqueduct failure) is not anticipated to be part of the master plan scope of work, the pump curve information is not necessary.

- Pressure Regulating Stations (PRS) – Electronic and hard copy information was provided for 68 pressure regulator stations. The data provided includes the upstream and downstream pressure zones, site elevation, general notes, hydraulic modeling notes, model status (open, closed, not modeled, etc.), valve sizes with manufacturer and pressure settings (reducing and sustaining) for each, and the HGL of the upstream and downstream pressure zones.

  The hard copy data also included as-builts, site plans, and miscellaneous schematics and notes for the Aviara PRS, Bolero PRS, Cannon PRS, College East PRS, College West PRS, College North PRS, College South PRS, D-3 PRS, E Reservoir PRS, Faraday Lower PRS, Faraday Upper PRS, Foxtail Loop PRS, Hailey PRS, Hilton PRS, Jackspar PRS, Melrose PRS, Palomar West PRS, Pointsettia El Fuerte PRS, Rancho Pancho PRS, Salk PRS, Sierra Morena PRS, and Tamarack Point PRS.

  Accurate PRS data is critical to a complex hydraulic model, such as the CMWD water system, with its numerous interconnections between pressure zones. The data provided by CMWD is sufficient to include each major operating PRS in the model. The pressure sustaining operations and assumptions made in the prior hydraulic model are extremely valuable and will serve as the initial starting point for model calibration. The data in the model will be compared with the hard copy and electronic data provided by the City and updated as needed. Any pressure setting or operating changes in the system that have been made since April 2009 will need to be provided by the CMWD Operations staff in order for the model to reflect a system change.

- Reservoirs – Information was provided electronically for 17 reservoirs, 2 of which are for the recycled water system, and 2 potable reservoirs that are currently out of service. Information provided includes the base elevation, dimensions, volume per height of reservoir, operating capacity, total height, spillway height (overflow elevation), controlling pressure zone, source water, year constructed, and material.

  The hard copy data also included as-builts, site plans, and miscellaneous schematics and notes for Maerkle Dam, Elm Reservoir, Skyline Reservoir, and D Reservoir.

  Reservoir data is sufficient for hydraulic modeling.

- CWA Connections – Hard copy data was provided for the CWA connections. This data included daily system flows for 2004 and 2005 and monthly CWA bills for water use from January 2004 through February 2005. Daily flow information, as logged by CMWD Operations staff for each connection point, was provided for calendar years 2006 through 2008. *CWA data is sufficient for hydraulic modeling and will be used to determine boundary conditions.*

- Water Quality – Electronic .pdf files of CMWD's water quality sampling points, temperature contours (October 18, 2005), chlorine residual contours (October 18, 2005), and monitoring results for April 23, 2009, May 6, 2009, and June 2009were provided for review. *The water quality data provided gives a basic understanding of water quality throughout the system.*

- Miscellaneous hard copy information was also provided regarding the different billing codes used by CMWD and hydraulic modeling notes. *These notes could be valuable in analyzing the model.*

<u>Facility Plan Sheets</u> – On November 5, 2009 CMWD provided hard copy plan sheets for the Terramar PRV removal (Sheets 1-3), the El Camino Real 24-inch main and regulator construction sheets 1-7 (Dwg No. 406-1), and one sheet of the general process schematic for the Maerkle site (Sheet 3 of 48).

<u>Hydraulic Water Model</u> – CMWD's 2005 H_2OMAP v9.0 water model was provided for use in this 2010 Water Master Plan Update. This model contains scenarios using 2001 data (average day, minimum day, maximum day, and fire-flow demand conditions) used for the 2002 Master Plan and a single 2005 average day demand scenario ("ADD2005"). This 2005 scenario will be used as the basis for the 2010 Master Plan hydraulic model and analysis as it includes water system improvements from 2001 through 2005. *CMWD's 2005 model was originally constructed knowing that CMWD's H_2OMAP license restricted the size of the model to less than 3,000 pipes. This 2010 Update will use an unlimited pipe version of the software, and will not have this restriction.*

Data included in the 2005 hydraulic model includes:

- Average day demands equal to 15.87 MGD.
- Junctions: 2,864 total junctions
  - 2,864 junctions include information on pressure zone and. Whether or not a junction is a demand junction is also included in the database for all junctions.
  - 235 junctions include the installation year.
  - 152 junctions include miscellaneous comments.
  - 1,955 junctions include field a called "VLV_TYP" and requires clarification from CMWD.
- Pipes: 3,701 total pipes
  - 3,701 pipes include information for length, diameter, and pressure zone ("ZONE"). There is a second field for the pressure zone ("PRES_ZONE") that includes data for 3,339 pipes and conflicts with the information in the "ZONE" field. It is assumed that the "ZONE" field is used based on review of the data and because the queries in the model are established using this field.
  - 3,144 pipes (approximately 85%) include information for the installation year.
  - 3,301 pipes include information on the pipe material. The pipe description for 114 PVC pipes includes the pressure class.
  - 6 pipes are initially closed.
  - 42 pipes have control to open and close based on the level of a system node. However, all but 1 of these pipe controls are disabled.
- Valves: 94 total valves

- 94 valves include information for the type of valve, diameter, and pressure setting. A pressure zone (“ZONE”) is identified for each valve, which appears to be consistent with the downstream pressure zone that the valve serves.
    - 12 valves include information for the installation year.
    - 59 valves include miscellaneous comments.
    - 43 are initially closed.
- Reservoirs (tanks): 10 total
    - 10 tanks include information for elevation (base), minimum level, maximum level, initial level, diameter, type, and atlas page number.
    - 6 tanks include information on the zone they serve.
- Reservoirs: The Maerkle Dam (Reservoir) is not included in the 2005 hydraulic model.
- CWA Connections: 4 connections
    - 4 connections modeled as fixed-head reservoirs. Connection grade is included, as well as atlas page number.
    - 2 connections include the pressure zone that they serve.
- 58 different database queries with 17 query sets.
- 9 demand patterns:
    - 4 diurnal (24-hour) patterns
    - 5 steady-state patterns
        - The 2005 ADD scenario includes a steady-state analysis.
- 4 disabled rule-based controls. However, the 2005 ADD scenario does not use rule-based controls.
- No water quality data exists in the model as received.
- No model notes are included in the model as received.
- No external links currently exist between the model and any GIS data per the GIS Gateway function

The water system network is shifted in several areas from the alignments shown in the GIS. In some instances the piping will need to be redrawn to align correctly with the GIS data. Also, new development and in-fill projects have occurred since the model was last updated in 2005. These areas will need to be added to the hydraulic model to adequately represent CMWD’s water system during our calibration period. Having accurate connectivity and looping in the hydraulic model is critical to both the hydraulic and water quality calibrations. Overall, the data provided in the 2005 hydraulic model is sufficient as a starting point for the 2010 update.

GIS Data – GIS data files were received to support the Master Plan efforts. All data is in a geodatabase format and came in three separate packages (7/28/09, 8/3/09, and 8/4/09). The water geodatabase is updated by the engineering staff and refreshed nightly to the City’s centralized Spatial Data Engine (SDE) database. The water GIS data files provided were updated last on 07/02/09, but may not include all water system changes due to the level of backlog in the department.

All data layers have unique identifiers assigned. Other applicable attributes are listed below alongside the feature classes.

- 4108195_09_DataRequest.gdb
  - Roads (SanGIS)
  - 2 ft Contours (Source and age unknown)
  - Carlsbad municipal boundary (SanGIS)
  - Parcels (SanGIS) – These parcels are a selection of the County-wide parcel database which includes parcels in the City of Carlsbad only. Standard attribute fields include owner, address, APN, and many others specific to individual properties. The land use code included in this database is very general and rarely updated. For more accurate land use data, PBS&J was directed to use the SanDAG GIS data layers.
  - Park boundaries – Maintained by the City of Carlsbad.
  - Sewer Districts – Polygons were provided for the Vallecitos Water District, Leucadia County Water District, Carlsbad Municipal Water District, and an unnamed polygon to the east.
  - Water Districts – Polygons were provided for the Carlsbad Municipal Water District, Vallecitos Water District, and Olivenhain Municipal Water District.
  - Water Bodies
  - 2005 DEM (digital elevation model)
  - Land Use (SanDAG, 2008) – Existing land uses only. No future land use data was provided.
  - USGS Rivers
- 4108195_09_DataRequest 2.gdb
  - Surveyed City Boundary (polyline)
  - Survey Control Points
  - Water mains (18,107 polyline features) – important water system attributes include:
    - All pipes include the diameter, material, length, pressure zone
    - 16,641 potable water main segments and 1,466 reclaimed water main segments
    - 16,500 potable water segments that are “active” in the database
    - 1,381 active potable water pipe segment are missing the pressure class rating
    - 4,057 active potable water pipe segments are missing the as-built date
    - 842 active potable water pipe segments are missing the drawing number

- Water laterals (34,770 polyline features) – important water system attributes include:
  - All laterals include the diameter, material, length, pressure zone
  - 33,841 laterals are potable and 929 are reclaimed
  - 33,789 potable laterals are "active"
  - 11,846 potable laterals are missing the APN number associated with the account

- 4108195_09_DataRequest3.gdb
  - Hydrants (4,212 point features) – important water system attributes include.
    - All hydrants include the diameter and pressure zone.
    - 4,211 are active potable hydrants. 1 is reclaimed and active.
    - 4,107 hydrants are missing data for the type of hydrant.
    - 1,296 hydrants are missing as-built data.
  - Pumps (13 point features). Child records to the pump stations in the Station feature class. One-to-many relationship. Relevant water system attributes include:
    - All pumps include the capacity in gpm, motor manufacturer, amps, motor speed, and pump manufacturer.
    - 4 pumps include notes.
    - 10 pumps include the horsepower.
    - 2 pumps include information on the type of motor:
      - 1 variable speed
      - 1 constant speed
    - Impeller size, diameter of the pump, and design head were not provided.
  - Pressure Regulators (142 point features). Child records to the PRS points in the Station feature class. One-to-many relationship. Relevant water system attributes include:
    - All regulators include the diameter and "function" – RF, R-S, S, ALT, NA, UNK. A description of these functions was not provided.
    - Pressure settings were provided for the varying functions as noted above.
    - 3 regulators are future.
    - 1 regulator is not-in-service.
    - 50 regulators have notes.
    - No information was provided regarding the upstream or downstream pressure zone.
  - Reservoirs (tanks) (17 point features). Relevant water system attributes include:
    - All tanks include the address, name, shape, material, placement (above ground, below ground, and partially-buried), and base elevation.

    - 13 potable water tanks and 4 reclaimed water tanks.
    - 10 potable water tanks include the high water elevation.
    - 2 potable water tanks include the low water elevation.
    - 11 potable water tanks include the height.
    - 3 tanks include cathodic protection information.
    - 7 tanks include the liner type, all of which are epoxy.
    - 1 tank includes the as-built information.
    - 10 tanks include the diameter.
  - Stations (95 point features). Relevant water system attributes include:
    - Includes 10 pump stations, 80 PRSs, and other coded features (WCLS, CRC, and ITC).
    - 80 stations are potable and active.
    - 75 active potable stations include the source zone information.
    - 67 active potable stations include as-built information.
    - 45 active potable stations include notes.
    - 15 active potable stations are connected to SCADA.
    - Suction and discharge diameter was not provided.
  - Valves (39,261 point features). Relevant water system attributes include:
    - All valves include information on the pressure zone and type of valve.
    - 36,283 valves are potable and active.
    - 8,696 valves include notes.
    - 27,308 valves include as-built data.
    - 36,280 valves include the diameter.
    - 2,830 valves include the elevation.
    - 13,084 valves include the normal status of the valve.

2008 Aerial imagery was also provided along with a shapefile with the latest geo-coded water meters (FinalWaterMeters06_09.shp).

Some of the base data is part of the County-wide GIS repository which the City does not maintain separately. These include: Parcels, Roads, and Zoning. SanGIS is a public agency that maintains and stores data for the County of San Diego. This GIS data is made available to the public and includes the layers noted above.

The GIS data provided will be used to update the hydraulic model. For the purpose of hydraulic modeling the data is fairly complete, and most gaps can be completed with the hard copy information received or through conversations with CMWD staff. However, age of pipe is essential to determine an accurate rehabilitation and replacement program. The GIS data has nearly 73 percent of this information.

Demands – CMWD provided a GIS shapefile and database of the meter coverage within the service area on August 13, 2009. The database included 28,839 unique accounts that included the customer name, address, customer subclass (land use), meter size, and annual total water use in hundred cubic feet (hcf) for calendar years 2004 through 2008 and for 2009 through July. The data also included:

- 1,288 inactive or "closed" accounts. However, 58 of these accounts have water use for 2009 and will need to be discussed with CMWD. Total active accounts = 27,551 for 2009.
- Customer subclass, or land use, used in the billing data includes:

AG = Agricultural	IR = Irrigation
AH = Agricultural with House	M = Multiple
AR = Agricultural Rebate	M1 = Multiple pdu
C = Commercial	RC = Recycled Water
D = Duplex	S = Single Family
FP = Fire Protection	SF = Single Family with Fire
IN = Industrial	TP = Temporary Potable

- The total demand for the 2005 year based on billing records is 17.77 MGD, which is higher than what was used in the hydraulic model for the same year.

Demands for the base analysis for the 2010 Water Master Plan modeling will be based on 2007 average demands in conjunction with the 2009 meter coverage. The 2007 water demands represent pre-drought conditions for CMWD, while the 2009 water meter coverage includes those new accounts that have become active since 2007 and were active during the calibration period.

The water demand data will require a thorough review to determine which accounts were in fact using water in 2009 versus those accounts that were active, but not using water. Also, based on discussions with CMWD staff, those accounts that are deemed active in 2009, but were not active in 2007, would have a unit demand factor applied, based on existing land use. It is anticipated that a number of accounts that are classified as active are vacant buildings. Assumptions will need to be made regarding the actual status (active vs. inactive) of some meters. The total water demand determined through this process will only be used to calibrate the hydraulic model.

DataMart – CMWD provided a hard copy print out of their active meters as recorded by their DataMart system as of November 5, 2009. This data included 27,043 potable active meters, which differs from the meter data received in August. The data includes the total number of active accounts by year for each Customer Subclass as listed above.

Potable Water Make-up Meters – On November 5, 2009 CMWD provided a hard copy of the water meter setup information for the three make-up meters: D Tank, La Costa South Lake, and La Costa North Lake. This information included the meter number, account information, type, manufacturer, and status. These meters register the amount of potable water added to the recycled water reservoirs to meet peak demands on the recycled water system.

Robertson Ranch Master Plan – On November CMWD provided a hard copy of the November 2004 Master Plan, Section IV – Public Facilities and Infrastructure Plan and Appendices A through E.

CWA Delivery Data – CMWD provided a spreadsheet of the 2006 through 2008 monthly delivery totals, based on actual billing information, for the four connection points for the system. The spreadsheet also included volume calculations to determine the volumetric change in Maerkle Reservoir.

Water Quality Data – On July 30, 2009 CMWD provided a CD of electronic files containing water quality sampling points and test data from the past several years, including pdf files:

Exhibit 7 - Sample Site Data Temperature Contours (*October 18, 2005)*

Exhibit 8 – Sample Site Data Temperature Contours (J*uly 12, 2005)*

Exhibit 9 – Sample Site Data Chlorine Residual Contours (*October 18, 2005)*

Exhibit 10 – Sample Site Data Chlorine Residual Contours (*July 12, 2005)*

Bacteriological Sample Site Plan System No: 3710005 (*April 2008)*

Sample Site Plan DBPR Monitoring Plan System No: 3710005 (*September 2006)*

CDPH Bacteriological Sample Siting Plan (*February 26, 2008*)

Monthly System Monitoring Reports for June 2009

Reservoir monitoring results for April 23, 2009

Reservoir monitoring results for May 6, 2009

This information provides a basic understanding of water quality throughout system and will be used as a starting point for setting up the water quality calibration work.

Carlsbad Sewer Master Plan (Draft) – On October 29, 2009 CMWD provided a hard copy version of the October 2009 Sewer Master Plan (Draft) prepared by Dudek.

Supervisory Control and Data Acquisition (SCADA) – Over the course of the field testing program, CMWD Operations staff collected SCADA information necessary for the calibration of the hydraulic model. One-minute intervals were recorded. Files were received daily during the testing period (August 24 through 27, 2009) and on September 17, 2009 for August 28 through September 2, 2009. There are points within the data where the signal was not received and therefore caused NULL readings within the data. Typically these NULL readings were only for one or two minutes.

- **Flow –** SCADA flow information was received for the following:

  CWA Connection Nos. 1 through 4

  Inflow and Outflow for D-3 Tank

  Inflow to Maerkle Reservoir

  Flow for Maerkle Pump Station

  Outflow for Maerkle Tank (negative readings for the first 40 hours)

Flow for Bressi Pump Station (zero for all days)

Flow for Calavera Hills Pump Station (zero for most days, with NULL readings the first 40 hours)

- **Tank/Reservoir Levels –** SCADA level information was received for the following facilities:

D-3	La Costa Low
E	Santa Fe II
Elm	Sky
Ellery	Maerkle Reservoir
La Costa Hi	Maerkle Tank East and West

- **Pressure –** SCADA pressure (U=Upstream and D=Downstream) information was received for the following facilities:

TAP U/D	Ellery Tank sustaining
Ayers PRS U/D	Kelly PRS U/D
CWA Connection Nos. 1, 3, and 4	May Co. PRS U/D
D-3 Tank U/D	Melrose PRS U/D
El Fuerte U/D	Point D PRS U/D
Elm TAP U/D	Palomar PRS U/D

Zodiac PRS U/D (NULL readings for both for the first 40 hours)

Calavera Hills Pump Station suction and discharge (NULL readings for both for the first 40 hours)

Jackspar U/D (Zero or NULL for the entire testing period)

Maerkle Pump Station suction and discharge

Tanglewood U/D (NULL readings for the first 40 hours)

The SCADA information received is sufficient to calibrate the hydraulic model. A few facilities did not record during the time period selected, and will therefore not be used as a calibration point for the model calibration. We do not believe the missing SCADA data will impact model calibration.

Additional Field Testing Information – Over the course of the field testing program, CMWD Operations staff also collected field pressure readings necessary for the calibration of the hydraulic model. Fourteen (14) Dickson pressure recorders were installed at critical pressure regulating stations that did not have SCADA, and 12 Telogs were installed on fire hydrants throughout the distribution system. During the test period the data was collected every three days for the Dicksons and only once for the Telogs.

- Dickson Pressure Data – The Dickson pressure recorders were set to record the pressure at one-minute intervals.

College East PRS U/D

College West PRS U/D

Palomar Oaks PRS U/D

Chestnut PRS Downstream

Pointsettia PRS U/D

Point D South PRS Upstream

Bressi PS Suction

Jackspar PRS U/D (Upstream Dickson was not recording for the first 3 days.)

Kelly PRS Downstream (Anomalous readings after Day 3.)

- Telog Pressure Data – The 12 Telogs were set to record the pressure at 10-second intervals.

Tamarack at James Dr.

Gabbano Lane @ Grvetta Court

Tamarack at Carlsbad Blvd

Columbine @ Geranium

Cannon at El Arbol

Rutherford at Farnsworth

Hemingway at Cannon

Lugiernaga at Cantil

College at Rift

State at Beach

Village Glenn at Paradise

Tamarack at Amberwood

FUTURE DATA NEEDS
See Data Needs List, dated December 29, 2009, attached.

DATA QUALITY SUMMARY
Overall, CMWD has provided a comprehensive data package to facilitate an update of the hydraulic model and water demand disaggregation. The data received is consistent with our scope of work and expectations. Remaining key data anticipated over the next month include:

- *Growth Management Database estimates for projecting future population and demands, and Local Facility Management Zone (LFMZ) information and coverage*
- *Desalinated water supply locations*
- *Interagency agreements for emergency service*
- *Coordination with the Recycled Water Master Plan on the conversion of potable irrigation meters*